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Magnetic, electrical transport and thermal properties of $\mathrm{Ce-Ni-Ge}$ compounds

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Basic physical properties of $\mathrm{CeNiGe_3}$, $\mathrm{Ce_2Ni_3Ge_5}$, $\mathrm{Ce_3Ni_2Ge_7}$ and $\mathrm{Ce_3NiGe_2}$, have been studied by means of DC and AC magnetic susceptibility, magnetization, resistivity, magnetoresistivity and heat capacity measurements, performed in wide ranges of temperature and magnetic field. All the compounds have been found to exhibit localized magnetizm due to the presence of rather stable $\mathrm{Ce^{3+}}$ ions. $\mathrm{CeNiGe_3}$ and $\mathrm{Ce_3Ni_2Ge_7}$ order antiferromagnetically below $T_\mathrm{N} = 5.5$ and 7.5 K, respectively. For $\mathrm{Ce_2Ni_3Ge_5}$ two antiferromagnetic transitions at $T_\mathrm{N} = 5.1$ K and $T_1 = 4.5$ K have been evidenced. Two subsequent phase transitions have been found also for $\mathrm{Ce_3NiGe_2}$ but in this case antiferromagnetic spin arrangement below $T_\mathrm{N} = 6.2$ K is replaced by a ferromagmetic one below $T_1 = 5.2$ K. All the compounds studied show metallic character of the electrical conductivity with some evidence for Kondo effect. Their electronic specific heat is rather moderately enhanced. The magnetic properties of the compounds investigated will be compared to the behavior of some other phases from the $\mathrm{Ce-Ni-Ge}$ system, e.g. $\mathrm{CeNi_2Ge_2}$ and $\mathrm{CeNiGe_2}$, and discussed in terms of crystal structure dependent differences in the strength of f-ligand hybridization.